

lished in 1870 as the "Geology and Physical Geography of Brazil." In addition to the account of Hartt's researches, it included the best results of all who had ever published on the geology of the country.

Early in 1868 he was elected Professor of Natural History in Vassar College, and shortly after of Geology in Cornell University. In 1870, with Prof. Prentice and eleven students of Cornell University, he again went to Brazil. He entered the Amazonian Valley, hoping there to discover, at the falls of the different tributaries of the Amazonas, other fossiliferous formations than the cretaceous, which latter alone he had found along the coast. He was well rewarded, and returned to the United States with large collections of fossils of the palæozoic age, and sufficient other evidence to allow of his giving us a very accurate though general idea of the formation of the Amazonian Valley. His results were strongly opposed to the theory of Prof. Agassiz, of its glacial origin. He returned again to the Amazonas in 1871 with Mr. O. A. Derby. Together they carefully re-explored the same regions gone over before, adding much to the stores already brought to the United States, and also examining the ancient Indian mounds and shell-heaps of numerous localities.

Returning from Brazil once more he remained at Cornell University about three years, quietly working up the results of his later trips, and publishing his reports upon them. In August of 1874, by request of the Brazilian Minister of Agriculture, he went to Rio de Janeiro to submit his plans for the organisation of a Geological Commission of Brazil. He entered on his work in May, 1875, with five or six assistants.

On the reorganisation of the National Museum at Rio, in 1876, Hartt became Director of its Department of Geology, but on account of his many other duties he was soon obliged to resign that position. The results of his researches may be briefly summed up as follows:—Before he went to Brazil on his second trip, in 1867, scarcely anything was known of fossiliferous deposits there, and thus no material existed toward the study of the systematic geology of the country. A few cretaceous fossils had been recorded from Bahia; the Danish naturalist Lund had very fully described the bone-caverns of Lagoa Santa in Minas Gerães, and we knew of coal-plants from Rio Grande do Sul, but beyond this the palæontology of Brazil was a perfect blank. Hartt's greatest achievement in Brazil was probably his solution of the structure of the Amazonian Valley. It was founded on the best of palæontological evidence which proves the existence of an immense palæozoic basin lying between the metamorphic plateau of Guiana on the north, and that of Central Brazil on the south, and through which flows the river Amazonas. Silurian, Devonian, and carboniferous rocks, make up the series in regular succession, and in many localities are highly fossiliferous. He has explained the character of the isolated cretaceous deposits, mostly discovered by himself, existing along the coast from Pará to Bahia, and of the carboniferous and other regions south of Rio. He has shown us the manner in which the rocky structure of Brazil was built up, and has done much toward solving the relations of the crystalline rocks which compose by far the larger portion of its surface. He has explored the shell-heaps, burial-mounds, and other relic-localities of the prehistoric tribes from far up the Amazonas to the southernmost coast province. We owe to him also the first real satisfactory explanation of the reefs of Brazil, which he distinctly shows to be of two kinds—sandstone and coral. He spent much time in studying the customs and languages of the modern Indian tribes of the Amazonas and Bahia, and collected very much material toward a grammar and dictionary of the Tupé Indian language in several of its dialects. But to attempt a complete account of Prof. Hartt's Brazilian explorations and dis-

coveries would require a longer article than we can give here. In connection with the Geological Commission of Brazil he founded a large museum in Rio de Janeiro, which will always bear testimony to his great final undertaking. It forms the most complete repository of South American geology in the world.

A start had just been made toward publishing the reports of the commission when the death of Prof. Hartt deprived it of its main support. But though this will occasion some delay in the publication, it is to be hoped that we shall soon have before us the entire results of this most important of explorations.

Prof. Hartt's published works are not very voluminous. He was so confident of a longer life that he delayed too long, but still he was a constant contributor to American scientific periodicals.

THE DARK CONTINENT¹

IN our article last week on "Old Maps of Africa" we said that even if it were the case that the great lakes and rivers of Central Africa were known to early Portuguese missionaries and traders, it would not in the least detract from the glory of modern African explorers. Even if the work of those early travellers had not been clean forgotten, it was done so imperfectly that in any case it would have had to be done over again; their work bears about the same relation to that of modern explorers that the observations of an ancient Chaldean shepherd watching with powerless eyes the march of the stars, while he tended his flock on the hill-side, do to those of a modern astronomer armed with all the instruments of an observatory. It scarcely needs a perusal of these two volumes to convince us that it would be simply absurd to attempt to deprive Mr. Stanley of the glory of being the first white man whose keel has cleaved the broad bosom of the Upper Congo. He has done *his* work in such a way that there is no chance of it being ever forgotten.

Let us at once assure those of our readers who may cherish the idea that, after having read Mr. Stanley's letters in the *Telegraph*, they need not trouble themselves with his book, that they labour under a delusion; compared with the book, the letters are a mere prospectus, and therefore we cannot hope within the limits of an article to give any adequate idea of its contents. From a merely literary stand-point, Mr. Stanley's work deserves to take a high rank. We know no other narrative of travel with which it can be compared; it reads more like a prose epic than a story of stern facts, and the reader who remembers his classics will be over and over again reminded of the story of the wanderings of Ulysses as chanted by Homer. No such revelation of African life and African character and African scenery has ever been made, scarcely, we think, even in the half-fictional pages of Winwood Reade. The trustworthiness of Mr. Stanley's narrative cannot for a moment be doubted; his art has been evidently used simply to enable us to realise with perfect clearness the scenes and events through which he and his followers passed.

From the numerous notices we have published, our readers must be familiar with the great outlines of Mr. Stanley's discoveries. The two volumes before us are concerned mainly with the incidents of the wanderings of himself and followers from Bagamoyo to the mouth of the Congo; another volume, which is promised for autumn, will contain chapters on the hydrography, ethnology, and natural history of Central Africa, with "considerations" on the lakes, lands, and peoples of the equatorial regions; as well as chapters on the hydrography and physical geography of the western half of

¹ "Through the Dark Continent, or the Sources of the Nile, around the Great Lakes of Equatorial Africa, and down the Livingstone River to the Atlantic Ocean." By Henry M. Stanley. Two vols. Maps and Illustrations. (London: Sampson Low and Co., 1878)

Africa, with special reference to the Livingstone Basin and River, and the volcanic formation of the defile through which the Livingstone falls into the Atlantic. Until the publication of this third volume it would be premature to discuss in detail the scientific results of the expedition, and we shall therefore at present content ourselves with briefly resuming the general results of Mr. Stanley's work.

Mr. Stanley left Bagamoyo on November 17, 1874, with a force of porters, soldiers, and boatmen of about 350. The expedition was thoroughly equipped for its work, and it is evident that the best possible use was made by Mr. Stanley of all his advantages. The objects of the expedition were not rigidly defined, and generally they may be said to have been to clear up the many unsolved problems relating to the sources of the Nile, the great



Scene on Lake Tanganika.

lakes of Central Africa, and the course of the great river, which, coming from the far south, passed Nyangwé, and flowed then no man knew whither. The ultimate source of the Nile was unknown; the configuration of the Victoria Nyanza was so uncertain, and so many objections had been raised to Speke's work there, that, as Mr. Stanley says, there was some danger of its being swept off the map entirely; so defective was our knowledge of

the lake, that some geographers, including the sagacious Livingstone, maintained that it was not one lake but many; there was much to clear up in the region between Victoria and Albert Nyanza, and our knowledge of the latter was of the scantiest. The great western affluent of Lake Victoria, the Kitangulú, had to be traced, and our knowledge of Lakes Windermere and Akanyaru extended, as well as of the stretch between the latter and Tanganika.

On the last-named lake, notwithstanding the labours of Burton and Speke, Livingstone, and Stanley himself, and even of Cameron, there was not a little to do to complete our knowledge. Then there was much room for additional work in the interesting country lying between Tanganika and the Lualaba at Nyangwé, where Livingstone has left an everlasting memory as "the good old white man." Last of all there was the mile-wide Lualaba itself sweeping past Nyangwé, "north, north, north," into the great unknown, perhaps to the Nile, perhaps to some great lake, perhaps bending west to the Atlantic; though there could be little reasonable doubt that if a boat could run the gauntlet of the natives, it would find itself ultimately on the estuary of the Congo. These were the geographical problems to be solved, and Mr.

Stanley solved them, and he only took two years and a half to do it.

Until he reached Ugogo, nearly half way between Bagamoyo and Lake Tanganika, Mr. Stanley kept not far from the caravan route westwards, well known to all readers of recent African travel. Turning suddenly northwards, he made straight for the Victoria Nyanza, over a rugged table-land, interspersed with plains, and with at least one wide desert, and many villages. In about $5\frac{1}{2}^{\circ}$ S. lat. he came upon some tiny streams which he ultimately found to be the head waters of a river of something like 300 miles long, that runs into Lake Victoria as the Shimeeyu, and which is undoubtedly the furthest south source of the Nile. Camping at Kagehyi, on Speke Gulf, Mr. Stanley in his trim boat,



Cataract on Lower Livingstone.

the *Lady Alice*, circumnavigated the Victoria Nyanza, defining every creek and gulf, and proving it to be one great lake with an area of 21,500 square miles, an altitude of 4,168 feet, and with border-soundings of from 330 to 580 feet. The lake is bordered with islands all the way round, is much indented with creeks and bays, receives numerous tributaries from all sides, and its shores and many of its islands are thickly inhabited.

Mr. Stanley next set himself to the task of doing for the Albert what he had done for the Victoria Nyanza, but in this he was balked by the timidity of the escort furnished him by his warm friend Mtesa, King of Uganda, on the north of the latter lake. He was only able to stand on the precipitous shore of what he named Beatrice Gulf. From what he then saw, combined with the information gleaned at the court of King Rumanika, he has plotted on the map accompanying his work the vague outlines of a new lake, to which he attaches the name of Muta Nzigé, somewhat to the south of the

Albert Nyanza. The latter he locates in accordance with the recent circumnavigation of Col. Mason, with the proviso that after all there may be a connection between the two. If Mr. Stanley has not yet solved this problem, he has at least opened up a very interesting one, which possibly the Egyptian pioneers may unravel. Coming south to the coast of Ruminika, King of Karagwé, the gentle friend of Speke and Grant, and now of Stanley, he was able still further to add to our knowledge of a region teeming with interest, and again to open up problems which successive explorers must solve. We have now some idea of the great affluent of the Victoria Nyanza, which, issuing from Lake Akanparu, flows north through a long series of swampy lakes before it turns east to feed the great reservoir of the Nile. About Lake Akanyaru itself we know but little. Mr. Stanley, in the maps which accompany his work, no longer makes a long river flow from the west to feed it, though a considerable stream comes south from the Ufumbiro Mountains.

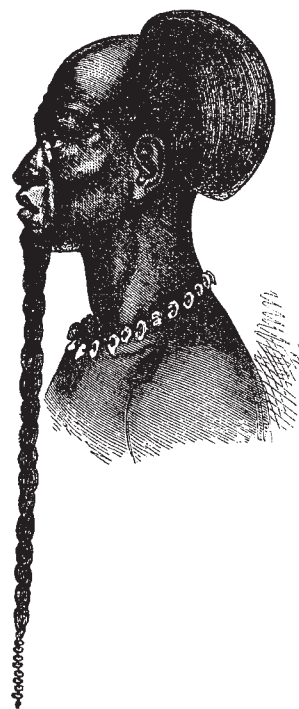
Still, however, he gives it a connection with little Lake Rivu, the supposed source of the Rusizi, the northern affluent of Lake Tanganika. Here is another curious riddle awaiting solution.

Coming to the Tanganika itself, we may say that Mr. Stanley has virtually completed our knowledge of its configuration, having for the first time defined the outline of its southern shore and proved that the Lukuga has not yet become an effluent, but promises ere many years to carry the waters of the lake to swell the volume of the Lualaba. Mr. Stanley adduces the strongest proofs that the Tanganika is rising with comparative rapidity, and it is possible that further research may show that the earliest Portuguese explorers, if ever they reached it, found two lakes on its site, divided by a ridge nearly half-way between its north and south points. Mr. Stanley, before he began his work of exploration, evidently used great diligence to qualify himself as an observer in geology and natural history. That he is a keen observer his work shows, and it is evident he has collected a mass of data in geology and natural history, as well as in ethnology, which will prove of the greatest interest to men of science, and which we may look for in the promised third volume. Evidently the geological conditions of the bed and shores of the Tanganika, as well as of the whole basin of the Livingstone, are unusually interesting and have occupied much of the explorer's attention. Until we have the whole of the data it would be premature to theorise. The lake Mr. Stanley makes out to be 329 miles long, with an area of 9,240 square miles. With 1,280 feet of cord he could find no bottom. Yet though the Tanganika is rising, Mr. Stanley seems to be of opinion that at one period nearly the whole of the great area drained by the Livingstone was under water, and that the numerous lakes to the west and south-west of Tanganika, with the river itself, are all that now remain of the great inland sea, if inland it was. On the banks of the Tanganika itself, high above the lake-level, he found rocks bearing distinct evidence of having been worn and rounded by water. Here is a splendid field for the enterprising geologist.

Of the great river itself, what more can we say but that, in the face of the most stupendous difficulties, he traced its course from Nyangwe to the sea? It is a splendid epic, this narrative of the expedition down this great river, whose banks are lined with the villages of hostile and cannibalistic natives, who literally hunted the little band for hundreds of miles. We doubt much if another man could be found who could have carried such an enterprise through with success. Anyone but Stanley would either have turned or been eaten ere the first cataracts were reached. One village street was fringed on each side with rows of skulls, which he was told were those of the soko—probably a species of chimpanzee. One of these, brought home by Mr. Stanley, was submitted to Prof. Huxley, who has diagnosed it as that of a human being. Of the dimensions of this river we have already spoken, and of its basin, of nearly a million square miles. Its discovery was worth all the sacrifices that were made; and, unless we are to count the pursuit of knowledge as an object of no worth, it must be admitted that Mr. Stanley has here done a thing that entitles him to rank in the first order of the pioneers of science. Apart from its high value as an addition to geographical knowledge, its importance as a highway to new fields of commercial enterprise cannot be overrated. North and south of it yet there are great white spaces to be filled up, but with such a magnificent base-line that should not be difficult to do.

Such is a brief outline of the principal geographical discoveries made by Mr. Stanley; but it gives the very faintest idea of what the reader will find in his book. Africa and African, to those who study these volumes, will be no longer mere names: the genius of Mr. Stanley

has infused into them the breath of life. Mr. Stanley's strong human sympathy, aided by his knowledge of the Kiswaheli, has enabled him to bring before us the natives of Central Africa with a dramatic vividness never before attained. Henceforth it will be inexcusable to lump together the Waswaheli, the Wagoro, the Waganda, the Wanyamwesi, the Wajiji, the people of Manyema, and the many other tribes that people this much-watered land, as mere uniformly characterless "niggers." In Mr. Stanley's pages we see these various states and many individuals, each with their distinctive characteristics. The *physique* of the various peoples, their manners, their houses, utensils, and weapons, their dress, their modes of life, and even their modes of thinking and speaking, their legends, are pictured for us by pen and camera and pencil in a manner that must impress the laziest reader. The ethnologists will be able to glean many facts and hints here, and still more we should think from the



Kité, Chief of Mpungu, near the Lualaba.

volume that is to follow. Mr. Stanley presents us with a remarkable legend from Uganda, the Kingdom of Mtesa, concerning a blameless priest named Kintu and his descendants, which is well worth the study of the comparative mythologist. We have another strange legend as to the origin of the Tanganika, and we should think that in his wanderings much material of a similar kind must have been collected by Mr. Stanley: if so he would do science a service by publishing it. The chapters devoted to Mtesa and his kingdom are of special interest, and the explorer's friendship with this remarkable potentate promises to be fruitful of results. Further interesting details are given as of the mysterious white people of Mt. Gambaragara on the east shore of Muta Nzigé, which must rouse the curiosity of ethnologists. We learn a good deal also about the wandering Watuta, the terror of Central Africa, and of King Mirambo, a sort of African Napoleon, whom, however, Mr. Stanley speaks of in high terms as superior both in character and intellect to the general run of African "kings." Much new information also have we on the

inhabitants of the Tanganika shores and the artistic people of Manyema, with their elaborately coiffeured heads. To speak of these people, and even many of the tribes on the banks of the Livingstone, as savages is a misuse of language. People who can build houses and organize villages and towns such as they do, who can work their native iron, ivory, wood, and bone, into all sorts of artistic and useful shapes, and who can reason and speak as Mr. Stanley shows us they do, have raised themselves to a level considerably higher than the savage. West of Tanganika, especially, the tribes seem very much mixed up, and there are many evidences that the Livingstone with the neighbouring region is a sort of borderland where several races meet, and where a constant struggle is going on. What can be made of these Africans under competent direction, Mr. Stanley himself has shown us in the case of his own people.

Of the various products, mineral, vegetable, and animal, of the country through which Mr. Stanley passed we have many glimpses. The natural wealth of the country is extravagant, and the botanist especially will find much that will interest him, especially as Mr. Stanley has been at the trouble of frequently giving the scientific names of the plants which he mentions.

There is ample furniture of maps in the work, all of them well-executed, though in Mr. Waller's two large maps there are occasional signs of carelessness in the spelling of names, and, very strangely, the memorable Vacovia of Sir Samuel Baker is omitted from the names on the east shore of Albert Nyanza. Beside the two large maps of East and West Equatorial Africa, by Mr. Waller, there are also an interesting series of five maps by the same hand, showing the progress of discovery in Equatorial Africa. There is, first, a portion of Dapper's map of 1676, very similar to that of 1701, which we gave last week, showing two great central lakes, from the most westerly of which, Zaire lacus, issue both the Nile and Congo. The next one shows our knowledge between 1849-56, with all the features of Dapper's maps swept away, and the first rude indication of Tanganika given. Then, between 1856-63, we have the work of Livingstone, Burton, Speke, Grant, enabling us to more correctly define Tanganika, locate Victoria Nyanza, and shadow out Albert Nyanza. The next stage, 1866-75, shows a great advance. By the labours of Schweinfurth, Baker, Livingstone, Stanley (first journey), and Cameron, the main features, from 10° N. to 15° S., east of 25° E. long.—rivers, lakes, and mountains—are filled in more or less accurately. Last of all come the results of the journey described in these two volumes, and which we have endeavoured to summarise in this notice. There is also a chart of the Lukuga creek, and two beautiful large-scale charts, by Stanford, of the Livingstone or lower falls (thirty-two in number), and of the upper or Stanley falls. Mr. Cooper has, as usual, done his part well in reproducing the numerous and varied illustrations; and altogether the get-up is thoroughly creditable to the publisher.

In conclusion, let us repeat that Mr. Stanley has done a great work, and told us all about it in a great book.

OUR ASTRONOMICAL COLUMN

THE TRANSIT OF MERCURY, 1868, NOVEMBER 4.—The second internal contact at this transit was well observed in many European observatories, though at others the bad definition and tremulousness of the sun's limb vitiated the results. If we calculate strictly from Leverrier's tables of sun and planet, with Prof. Newcomb's value of the mean solar parallax, $8''.848$, we shall have the following formula for reduction of the observed Greenwich mean time at any place to the centre of the earth:—

$$t = 20h. 59m. 51.9s. + [1.4056] r \sin l - [1.7832] r \cos l, \cos(L + 55^\circ 51' 5''),$$

where l is the geocentric latitude, r the radius of earth at the place, and L the east longitude from Greenwich.

A comparison with observations shows differences as below:—

Place of Observation.	Observed G.M.T. reduced to earth's centre.			Error of the Calculation.	
	h.	m.	s.		
Bonn	21	0	3.4	- 11.5	Three observers: extremes differ, 13.5s.
Christiania	—	6.3	— 14.4		
Durham	—	12.2	— 20.3		Four observers
Greenwich	—	6.9	— 15.0		
Leyton	—	12.6	— 20.7		Six observers.
Lund	—	14.4	— 22.5		
Madrid	—	13.8	— 21.9		Merino. Rupture of ring.
Marseilles	20	59	57.6	— 5.7	Leverrier.
"	21	0	12.6	— 20.7	Stephan.
Paris	—	7.6	— 15.7		Mean of André, Villardeau, and Wolff.
"	20	59	57.0	— 5.1	
Rome	21	0	10.4	— 18.5	Secchi and Mancini.
Vienna	20	59	55.5	— 3.6	Oppolzer.

At the Royal Observatory, Cape of Good Hope, where the transit was very completely observed, the sun's limb is stated to have been tremulous at the second internal contact, which probably accounts for the larger difference, $-32.2s.$, between calculation and observation.

BRORSSEN'S COMET OF SHORT PERIOD.—When the elements of this comet, at its first appearance in 1846, had been satisfactorily determined, it was pointed out by Mr. Hind, in a communication to the Royal Astronomical Society, that the comet must have made a very close approach to the planet Jupiter about May 20, 1842, and that probably to this near approximation the form of the orbit in 1846 might be attributed. The late Prof. D'Arrest examined this question more closely in the year 1857, and by the formulæ of the *Mécanique Céleste*, which had been already applied in the case of Lexell's comet of 1770, he ascertained that a great change of elements was then caused by the action of Jupiter, assuming the mean motion given by the observations of 1846 to be affected with no material error, as we now know to have been the case. He found that the greatest proximity occurred May 20.69, Berlin time, when the distance of the comet from Jupiter was only 0.0511 of the earth's mean distance from the sun, and that previous to April 19, 1842, the elements of the comet's orbit were as follows. The elements of 1846 are added for comparison:—

	Elements before the great perturbation.		Elements in 1846.	
Mean longitude, 1842, April 19.5...	237	16	...	—
Longitude of perihelion ...	133	27	...	116 28
" ascending node ...	107	44	...	102 40
Inclination to ecliptic ...	40	51	...	30 57
Eccentricity ...	0.59275	0.793865
Semi-axis major ...	3.68645	3.15352

These figures prior to 1842 are necessarily only a first approximation to the orbit then described, but they sufficiently explain the circumstance of the comet not having been observed before that year, since the perihelion distance was then greater than 1.5, and as Prof. D'Arrest remarked, under this condition Brorsen's comet would hardly be observable.

According to Dr. Schulz's elements for 1873, when the comet was last visible, the nearest approach of its orbit to that of Jupiter now takes place in $283^\circ 30'$, when the distance is 0.124, and thirteen revolutions of the comet are almost exactly equal to six revolutions of Jupiter. D'Arrest, from a rough calculation, considered that the orbit might again undergo great or complete change from the action of this planet in the year 1937. The only